FINAL REPORT

Grant: NAG 5-2389
Title: CARBON PRODUCTION IN INTERMEDIATE-MASS STARS
PI: R.B.C. Henry, University of Oklahoma
Co-PI: Karen B. Kwitter, Williams College
and J. Buell, University of Oklahoma
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The goal of our project is to remeasure emission lines in IUE spectra for a select group of 20 planetary nebulae, combine these lines with published optical line strengths, calculate chemical abundances, particularly of carbon, and employ detailed stellar evolution models to infer information about carbon production in intermediate mass stars. One of the primary motivations behind this work is the newly available final archived IUE spectra, in which spectra collected over the lifetime of the telescope have been consistently rereduced at GSFC using state-of-the-art algorithms. Thus, these newly released spectra represent improvements over ones reduced through the years with an evolving set of algorithms.

Since beginning our project in September, 1993, we have transferred to our home institutions and measured roughly 99% of the 325 SWP final archived spectra needed for our project. We have combined IUE spectra for the planetary nebulae PB6, H4-1, Hu2-1, and K648 with published optical spectra to determine abundances of He, C, N, O, and Ne in each of these objects. Results are published in Astrophys. J., 458, 215 (1996). A reprint of this article is enclosed. Analysis of a second group of objects, BB1, NGC 650, NGC 1535, NGC 2440, and NGC 7027, has similarly been completed and these results are in press in the Astrophysical Journal, due out momentarily. A preprint of this article is enclosed.

Last May we obtained optical spectra of seven of our target objects using the Goldcam Spectrograph on the 2.1m telescope at Kitt Peak National Observatory. These observations were undertaken in order to obtain spectra in which the slit positions more accurately matched those of the IUE observations for these objects, compared with the optical data available in the literature. Another motivation was to study sulfur in planetary nebulae by observing the [S III] lines at 9069, 9532Å as a method for deducing progenitor metallicity. These optical data are completely reduced and we are on track

to submit a third paper in December of this year reporting the results of the optical and IUE data and our analysis for these seven objects. An upcoming run in December with the same instrument will allow us to observe most of our other target objects then.

On the theoretical front, Jim Buell, using the newly-revised code for following AGB evolution has produced some models of K648, the halo planetary nebula in the globular cluster M15. This result has been submitted to the Astrophysical Journal, and we are awaiting the referee's report.

The pace of this project has continually accelerated since its beginning in 1993, and as such we expect to complete it by June, 1997.

Below is a summary of papers and conference presentations related to this work and supported by the grant.

PUBLICATIONS IN REFEREED JOURNALS[1]

1. "A NEW LOOK AT CARBON ABUNDANCES IN PLANETARY NEBULAE. I. PB 6, Hu 2-1, K648, AND H4-1", R.B.C. Henry, K.B. Kwitter, & J.W. Howard 1996, Astrophys. J., 458, 215.

2. "A NEW LOOK AT CARBON ABUNDANCES IN PLANETARY NEBULAE. II. BB1, NGC 650, NGC 1535, NGC 2440, & NGC 7027", K.B. Kwitter, & R.B.C. Henry 1996, Astrophys. J., in press.

3. "ON THE ORIGIN OF PLANETARY NEBULA K648 IN GLOBULAR CLUSTER M15", J. Buell, R.B.C. Henry, E. Baron, & K.B. Kwitter 1997, Astrophys. J., submitted.

PUBLICATIONS IN CONFERENCE PROCEEDINGS

1. "TOWARD UNDERSTANDING NUCLEOSYNTHESIS PATTERNS IN INTERMEDIATE-MASS STARS: C, S, & Ar IN PLANETARY NEBULAE", R.B.C. Henry, K.B. Kwitter, & J. Buell 1997, IAU Symposium 180, Planetary Nebulae, in press.

2. "AGB MODELS, THE YIELDS OF He & CNO PRODUCTS FROM INTERMEDIATE-MASS STARS, & PLANETARY NEBULA ABUNDANCES", J. Buell, R.B.C. Henry, & E. Baron 1995, BAAS, 27, 1402.

[1]Copies enclosed.

3. "AGB MODELS, THE YIELDS OF He & CNO PRODUCTS FROM INTERMEDIATE-MASS STARS, & PLANETARY NEBULA ABUNDANCES", J. Buell, R.B.C. Henry, & E. Baron 1995, in From Stars To Galaxies, PASP Conf. 98, 202.

4. "A NEW LOOK AT CARBON ABUNDANCES IN PLANETARY NEBULAE, K.B. Kwitter, R.B.C. Henry, & J. Buell 1995, Rev. Mex. Astron. Astrof. Conf., 3, 229.

5. "HELIUM IN PLANETARY NEBULAE; AGB MODELS, J. Buell, R.B.C. Henry, & E. Baron 1994, BAAS, 26, 1386.

6. "A NEW LOOK AT CARBON ABUNDANCES IN PLANETARY NEBULAE", K.B. Kwitter, R.B.C. Henry, & J. Buell 1994, BAAS, 26, 1385.

7. "ENVELOPE BURNING IN AGB STARS & THE ABUNDANCES OF ^{4}He and ^{14}N IN PLANETARY NEBULAE", J. Buell, R.B.C. Henry, & E. Baron 1994, BAAS, 26, 952.

CONFERENCES ATTENDED

1. IAU Symposium 180, Planetary Nebulae, Groningen, The Netherlands, August, 1996, K.B. Kwitter.

2. 187th Meeting of the American Astronomical Society, San Antonio, January, 1996, J. Buell & R.B.C. Henry.

3. From Stars To Galaxies, October, 1995, Crete, J. Buell.

4. Fifth Mexico-Texas Conference On Astrophysics, April 1995, Morelos, Mexico, K.B. Kwitter & R.B.C. Henry.

5. 185th Meeting of the American Astronomical Society, Tucson, January, 1995, J. Buell & K.B. Kwitter.

6. 184th Meeting of the American Astronomical Society, Minneapolis, June, 1994, J. Buell.